CLAIMS

What is claimed is:

1. A fuel cell comprising:

a separator plate including a flow field;

a membrane electrode assembly having an active area formed on a proton exchange membrane; and

a gas diffusion medium interposed between said separator plate and said membrane electrode assembly such that said active area is in reactive interface with said flow field, said gas diffusion medium including:

a hydrophobic layer formed adjacent said separator plate and in fluid communication with said flow field; and

a hydrophilic layer formed adjacent said membrane electrode assembly and in fluid communication with said membrane electrode assembly;

wherein a reactant gas is transported in said reactant flow field and distributed to said active area through said gas diffusion media.

2. The fuel cell of Claim 1 wherein said gas diffusion media comprises a porous structure and said hydrophobic layer is defined by a region of said porous structure adjacent said separator plate having a hydrophobic coating sufficient to provide a hydrophobic stratum.

3. The fuel cell Claim 2 wherein said hydrophobic coating comprises a polymer selected from the group consisting essentially of polytetraflourorethylene and fluorinated polyethylene-propylene.

4. The fuel cell of Claim 1 wherein said gas diffusions media comprises a hydrophobic lamina section defining said hydrophobic layer; and

a hydrophilic lamina section defining said hydrophilic layer, said hydrophilic lamina section being in contact with said hydrophobic lamina section so as to provide fluid communication therebetween.

5. The fuel cell of claim 4 wherein said hydrophobic layer is variable as applied in an in-plane direction of the gas diffusion media, providing areas of different degrees of hydrophobicity.

6. The fuel cell of claim 4 wherein said hydrophilic layer is variable as applied in an in-plane direction of the gas diffusion media, providing areas of different degrees of hydrophilicity.

7. The fuel cell of claim 4 wherein said hydrophobic layer is variable as applied in a cross-plane direction of the gas diffusion media, providing areas of different degrees of hydrophobicity across the gas diffusion media.

8. The fuel cell of claim 4 wherein said hydrophilic layer is variable as applied in a cross-plane direction of the gas diffusion media, providing areas of different degrees of hydrophobicity across the plane of the gas diffusion media.

9. The fuel cell Claim 4 wherein said hydrophobic lamina section comprises a polymer selected from the group consisting essentially of polytetraflourorethylene and fluorinated polyethylene-propylene.

10. The fuel cell of Claim 1 wherein said gas diffusion media comprises a porous structure selected from the group consisting of carbon paper, carbon cloth, graphite paper, graphite cloth, mesh noble metal screen and an open-cell noble metal foam.

11. The fuel cell of Claim 1, further comprising:

a water flow channel in said separator plate; and

at least one capillary element in fluid communication with said water flow channel, said at least one capillary element extending through said hydrophobic layer and terminating in said hydrophilic layer.

12. The fuel cell of Claim 11 wherein said capillary element comprises a via formed in said gas diffusion media.

13. The fuel cell of Claim 12 wherein a thickness of said hydrophilic layer exists between said via and said membrane electrode assembly to prevent direct contact of water on said membrane electrode assembly.

14. The fuel cell of claim 11 further comprising a water source in fluid communication with said water flow channel to delivery water to said at least one capillary element at a capillary delivery pressure.

15. The fuel cell of Claim 1 wherein said separator plate has a second flow field formed in a face opposite said flow field.

16. A gas diffusion medium for a fuel cell comprising a generally planar porous structure defining an in-plane direction and a through-plane direction, said porous structure providing a transport mechanism for reactant gas in said through-plane direction, said porous structure further including a hydrophobic layer formed on a first surface of said porous structure and providing a transport mechanism in the gas diffusion media for moisture in said in-plane direction, and a hydrophilic layer formed on a second surface of said porous structure and providing a transport mechanism in the gas diffusion media for moisture in said through-plane direction.

17. The gas diffusion media of Claim 16 wherein said hydrophobic layer is a stratum defined by a region of said porous structure having a hydrophobic coating.

18. The gas diffusion media of Claim 17 wherein said hydrophobic coating comprises a polymer selected from the group consisting essentially of polytetraflourorethylene and fluorinated polyethylene-propylene.

19. The gas diffusion media of Claim 16 wherein said porous structure comprises a hydrophobic lamina section defining said hydrophobic layer, and

a hydrophilic lamina section defining said hydrophilic layer, said hydrophilic lamina section being in contact with said hydrophobic lamina section so as to provide fluid communication therebetween.

20. The gas diffusion media of Claim 19 wherein said hydrophobic lamina section comprises a polymer selected from the group consisting essentially of polytetraflourorethylene and fluorinated polyethylene-propylene.

21. The gas diffusion media of Claim 16 wherein said porous structure comprises a porous structure selected from the group consisting of carbon paper, carbon cloth, graphite paper, graphite cloth, mesh noble metal screen and an open-cell noble metal foam.

22. The gas diffusion media of Claim 16, further comprising at least one capillary element extending through said hydrophobic layer and terminating in said hydrophilic layer.

23. The gas diffusion media of Claim 22 wherein said capillary element comprises a via formed in said porous structure.

24. The gas diffusion media of Claim 23 wherein a thickness of said hydrophilic layer exists between said via and said second surface to prevent water flow directly through the gas diffusion media.